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SOME ASPECTS OF INDIVIDUAL DIFFERENCES IN SCHEMATIC CONCEPT FORMATION

Sam H. Lane
Selby H. Evans

March 1972

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HUMAN ENGINEERING LABORATORY

ABERDEEN RESEARCH & DEVELOPMENT CENTER

ABERDEEN PROVING GROUND, MARYLAND

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The remainder of the studies sought to explore the potential relationship between SCF performance and the traditional individual differences variables of personality, intelligence and race. With regard to personality, no relationship was found between SCF performance and performance on Witkin's Embedded Figures Test. Consistent with previous work, SCF performance was found to be moderately related to traditional measures of classroom performance (I.Q. and math achievement). It also appeared that some aspects of classroom behavior, as measured by teacher ratings, were related to SCF, but not to I.Q. With regard to the variable of race, preliminary data suggests that the SCF performance of lower socio economic class black sixth-graders is comparable to that of their white, middle-class counterparts.

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SOME ASPECTS OF INDIVIDUAL DIFFERENCES IN SCHEMATIC CONCEPT FORMATION

Sam H. Lane[1]
Selby H. Evans[2]

March 1972

APPROVED: John D. Weisz
JOHN D. WEISZ
Director
Human Engineering Laboratory

[1] Now located at the Cleveland State University, Cleveland, Ohio

[2] Director, Institute for the Study of Cognitive Systems, Texas Christian University, Fort Worth, Texas

HUMAN ENGINEERING LABORATORY
U. S. Army Aberdeen Research & Development Center
Aberdeen Proving Ground, Maryland

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A series of studies is presented in an initial attempt to address issues thought to be related to individual differences in schematic concept formation (SCF). The first two studies were concerned primarily with task development. It was found that a task which required the subject to distinguish pattern from noise demonstrated relatively clear individual differences in learning.

The remainder of the studies sought to explore the potential relationship between SCF performance and the traditional individual differences variables of personality, intelligence and race. With regard to personality, no relationship was found between SCF performance and performance on Witkin's Embedded Figures Test. Consistent with previous work, SCF performance was found to be moderately related to traditional measures of classroom performance (I.Q. and math achievement). It also appeared that some aspects of classroom behavior, as measured by teacher ratings, were related to SCF, but not to I.Q. With regard to the variable of race, preliminary data suggests that the SCF performance of lower socio-economic class black sixth-graders is comparable to that of their white, middle-class counterparts.

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CONTENTS

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TABLES

SOME ASPECTS OF INDIVIDUAL DIFFERENCES

IN SCHEMATIC CONCEPT FORMATION

INTRODUCTION

This report presents results, their interpretation, and related ideas accumulated thus far in an on-going program of research on individual differences in schematic concept formation (SCF). The interpretations of results and theoretical speculations should be regarded as tentative; the nature of the terrain of the "new ground" is still not in sharp focus as yet. Further analyses of this data are in progress, but this report is presented to document and communicate the findings thus far obtained.

Previous research (52, personal communication[a]) has suggested that individual differences in performance on SCF tasks may be related to performance and aptitude variables of more general significance. Schematic concept formation itself has been more commonly studied as a behavioral phenomenon bearing upon theories of pattern perception (2, 3, 4, 14, 15, 17, 50, 51). In brief, SCF is a process or phenomenon in which subjects examine a set of unfamiliar stimuli or nonsense forms. The set of stimuli contains two or more classes, the classes being implicitly defined within the set of stimuli by the presence of covarying attributes. In other words, members of a particular pattern class tend to have in common a number of attributes, although none of the attributes are perfectly reliable as indicators of class membership.

The general plan for our producing nonsense stimuli of this sort is to define a set of attributes which would constitute a prototypical example of the class. A pattern generating program (16, 18) then is used to produce random deviations from the prototype under conditions which control the variability of each attribute.

Conceptually the problem of finding a pattern class may be regarded as analogous to examining a collection of personality profiles and identifying one type of profile which seems to be recurring. The various examples that constitute a single class of personality profiles are all somewhat different from each other but a common pattern can be found and perhaps even reproduced as a typical profile for that class.

Before assessing the role of individual differences in SCF, we should examine several points regarding the use of the term "individual differences." First, in psychological testing the approach primarily has been to think of an "individual differences variable," not just "individual differences." For example, there is one tradition which has been concerned with the influence of variables, such as, intelligence, sex and personality on other phenomenon (1). Other typical areas of interest within this tradition are the nature of intelligence, behavior genetics, cultural depredation and the nature of genius (1).

[a] Personal communication from Dr. Dwayne Simpson to Dr. Selby H. Evans, during November 1970.

Yet within a second area -- experimental psychology -- individual differences have occupied a relatively neglected existence. Travers (58) observed that experimental psychology in general has not been concerned with individual differences for a variety of reasons which range from sheer lack of interest to the absence of any adequate techniques of analysis. Travers made this point:

> ". . .the thinking of experimental psychologists and the thinking of those engaged in the study of individual differences shows little interaction and, in the absence of such interaction, one would hardly expect that the two areas would develop with a set of common variables. The furrow plowed by the experimental psychologist can rarely be expected to cross the furrow by the psychometrically-oriented psychologist. The two furrows aren't even in the same field (p. 22)."

Nevertheless, a review of recent articles support the possibility that this state of affairs may be changing. There is a growing concern with the role of individual differences in areas, such as: statistical learning models (63); susceptibility to visual backward masking (7); short-term memory and shift performance in concept formation (42); subjective organization (11), mediational styles (33); dissimilarities of perceptual structure (35); strategies in multivariate cue utilization for form recognition (44); and the Zeigarnik effect (20).

The actual use of the term in experimental psychology goes back to Merrill (43) who advocated the consideration of systematic differences in learning data which would otherwise be grouped into an "average curve." One objective within this tradition is to account for more error variance, and perhaps a clearer interpretation of the results is also provided. Some would suggest that the label of "group differences" is more appropriate in this case than "individual differences." To some extent this use fo the term "group differences" corresponds to the behavior geneticists' reference to a quality which is characteristic of a subpopulation representing a homogeneous gene pool.

The Vincent curve (32) was an early attempt to reveal the form of the learning function when the individual curves did not differ in form. Various proposals have been made over the years which have sought to relate individual learning functions to group functions (13, 31, 53, 54, 59, 60, 61). An issue which has pervaded this point of view has been that of the relationship between individual differences and general laws. In some sense, this argument is the idiographic versus nomothetic approach in a different guise. However, Vale and Vale (62) have cautioned that, "An idiographic recidivism at this time, though prompted by impressive evidence on biological specificity and reinforced by sure knowledge of environmental differences as well, would nevertheless be disastrous (pp. 1095-1096)." As opposed to recidivism, Vale and Vale (62) suggest that:

> "The key to the place of individual differences would seem to be the lawfulness with which organisms interact with environments. That is, the test of the effect of individual differences lies in the extent to which it matters which individuals are being used in the search for relations between environmental treatments and responses. Thus, we may expect that the differences between each and every point on an individual differences dimension may not be meaningful. . .and therefore a law specific to the individual falling at each point is not required. On the other hand, to ignore small differences is not the same as to ignore the dimension entirely, and when individuals are classified into groups fairly widely separated on the dimension, or into qualitatively different groups, we may expect that the differences will be meaningful. . .(p. 1096)."

Glaser (28) proposed a similar path to seek lawful organism-environment interactions. However, Glaser's emphasis is focused on the awareness of the limitations in the implicability of a scientific law. Furthermore, he states: "It is through the specification of limiting conditions that our hypothesized or theoretically derived relationships obtain concreteness (p, 13)." Individual differences are regarded by him as representative of such limiting conditions.

At this point, we decided to take a broad conceptual stance concerning the role of individual differences in SCF. First, systematic differences in learning curves ("group differences" by one definition) should be examined in an effort to determine if these curves represented any degree of differential processing. Once this determination was made, it should be possible to observe its variation across certain individual differences variables.

Working within this framework we decided to adopt a general research strategy which would have a twofold objective: (1) to develop appropriate methodologies for demonstrating individual differences in SCF, and (2) examine the relationship between SCF performance and several traditionally defined individual differences variables. Because we felt that information gained from pursuing one objective could contribute to the attainment of the other, both objectives were considered simultaneously.

Thus, the first two experiments were concerned primarily with task analysis and development pursuant to the first objective; while Experiments III, IV, and V placed more emphasis on the second objective. At points where it seemed appropriate we made an attempt to define the issues which appeared to be relevant to relating performance in SCF to that particular topic in individual differences, even though these issues may have been only tangentially related to the actual experimental manipulations.

THE TASK

Prior to a discussion of the specific studies, it will be useful to describe the task in some detail. The task was composed of six subtests designed to impose different requirements on the subject, and so, potentially to measure different aspects of cognitive performance.

The overall design is presented in Table 1. As can be seen, there are three behavioral requirements. The first is a simultaneous comparison task in which subjects are presented a series of 40 pattern pairs. Each pair represents either two examples from the same class or two examples from different classes; the subject is required to make a judgment of whether they are of the same class or not. Previous research suggests that this task primarily reflects the subjects' ability to select an appropriate set of features for discriminating between the classes. In general, it appears that very little in the way of memory is required for adequate performance on this task.

The second task presents the subject with a series of stimuli one at a time. In this task, there are again 40 stimuli and 20 of them are from the same pattern class. The other 20 are, in effect, single examples of 20 different pattern classes. Thus, from the subject's viewpoint, there is one pattern class that recurs. His task is to identify instances of this class. A logical analysis of the task, as well as previous evidence, suggests that this task imposes a substantial memory requirement for adequate performance.

TABLE 1

Design of the SCF Test

Behavioral Requirements	Task Number: Serriform Mode	Task Number: Linguaform Mode
Judgment of "same class" versus "different class" for stimulus pairs presented simultaneously	Task 1	Task 4
Identify examples of the recurring pattern in a series of instances in which only one pattern recurs	Task 2	Task 5
Identify new examples of the pattern seen in the previous task, in a series of instances composed of examples of that pattern class and examples of another pattern class	Task 3	Task 6

The third behavioral requirement employs a task quite similar to the second, except that in this case the subject is required to identify new examples of the pattern class he saw in the previous task. There are 20 of these, intermixed with 20 examples of patterns from another single class. Previous research suggests that discriminating one pattern class from another class is more difficult than the requirement of Task 2. Thus it would be expected that this task imposes an even greater memory requirement.

A second variable built into the design of the test is mode of representation. The first three tasks employ a graph-like (or serriform) mode of representation with VARGUS 9 stimuli (18). The second block of three tasks replicates the behavioral requirement with a new mode of presentation, linguaforms, or language-like patterns. Linguaforms are constructed from sequences of syllables; a particular pattern is characterized by a tendency for certain sequences of syllables to recur with high frequency. Research with linguaforms has been described by Hollier and Evans (34) and by Tracy (57). The serriform mode of presentation would seem to draw principally on visual abilities, while the linguaform mode has enough resemblance to language to suggest that it might draw upon the kind of pattern learning which would be required in learning a language.

The design of the test was such as to provide complete balance between these two variables, so that a subject's score could be separated into a component associated with mode of representation and another component associated with behavioral requirement. It was also expected that, within each task, a score could be obtained representing the subject's improvement in performance over the task.

Balancing for order was intentially omitted; the task was designed for administration in the order indicated by the task numbers. There were logical reasons for this decision. In the first place, Task 2 and Task 3 were inherently ordered by their requirements. The same was true for Task 5 and Task 6. In the second place, it was initially thought that Task 1 and Task 4 were the easiest task for their respective modes. Furthermore, previous evidence has suggested that the serriform mode is easier than the linguaform mode. In other words, a particular ordering of the tasks was chosen on the basis of some indication that this ordering would be from easiest to most difficult.

The responses used in the test were designed to permit the test to be used with standard multiple choice forms and yet to obtain some gradation on the subject's judgment of similarity between the stimuli or of confidence in his own decision. Thus, the response alternatives were as shown in Table 2. One of the objectives of Experiment 1 was to determine the most satisfactory method of scoring these responses.

TABLE 2

Response Alternatives on Subjects Judgment of Similarity Between Stimuli or of Confidence in His Own Decision

	very similar and very probably same	very similar and probably same	very sure - recurrent	very sure-recurrent from previous task	fairly similar and seem likely same	fairly sure - recurrent	fairly sure-recurrent from previous task	not really similar or dissimilar and hard to say whether same or not	hard to say if recurrent or not	hard to say if recurrent from previous task or not	fairly dissimilar and seem likely different	fairly sure is not recurrent	fairly sure is not recurrent from previous task	fairly dissimilar and seem likely not same	very dissimilar and probably different	very sure is not recurrent	very sure is not recurrent from previous task	very dissimilar and quite probably different
General Instructions	X				X			X						X				X
Task 1		X			X			X			X				X			
Task 2			X			X			X			X				X		
Task 3				X			X			X			X				X	
Task 4	X				X			X						X				X
Task 5			X			X			X			X				X		
Task 6			X			X				X			X				X	

EXPERIMENT I

A number of studies have utilized the VARGUS 9 stimuli in a task similar to Task 1 of the present test. In most of these experiments the demonstration of the occurrence of learning was statistically significant but the effect appeared to be weak. It was also reported from time to time that the experimenter "felt" that people performed quite differently in the task. It was thought the weak learning effect could be due to averaging data into learning curves which did not possess adequate homogeneity. In order to test this hypothesis, it was necessary to administer the task to a large sample. A secondary gain from the use of a large sample was the acquisition of information about the task which could be assumed to be relatively free of subject sampling error.

Experiment I used only Task 1 of the SCF test, requriing the S to decide whether two simultaneously presented stimuli were from the same or from different classes. The five alternatives available to him ranged from confidence that they were from the same class to confidence that they were not from the same class. There were 40 such trials which in this case were presented on slides to 354 undergraduates in two large groups.

In order to assess alternative scoring methods, initially two sets of preliminary results were computed. For one set, a response was scored as correct only if the S chose the correct, extreme alternative. For the second set of results, a response was scored as correct if the S chose either alternatives in the correct direction (the less extreme or extreme). Examination of both sets of results, and later examination of similar sets ofresults of Experiments II, led to the conclusion that there was little implicative difference between the scoring methods and that for the present purposes the more liberal method was the most meaningful. This method was used in all further analyses.

The mean score for this task was 28.00 with a S. D. of 4.87; the reliability (KR-21) was .66. Examination of the frequency distribution of total scores revealed that it closely approximated a normal distribution.

The data from individual Ss were placed into one of five performance levels on the basis of total scores, and learning curves were generated for each of the levels. Inspection of these curves revealed that: (1) the cuves were virtually parallel for all five levels; (2) they were very similar to previous curves, which had demonstrated a very weak learning effect; (3) there was a great deal of block-to-block fluctuation in performance. An inspection of the responses of each group to each item revealed that this fluctuation was due primarily to individual item characteristics. The conclusion was reached that these results gave no evidence that the weak learning effect could be attributed to averaging in of homogeneous learning curves. It was decided that other tasks should be sought which might more clearly demonstrate differential learning and which offered a more powerful theoretical potential.

EXPERIMENT II

The main purpose of Experiment II was again to find a task or set of tasks in which it appeared that systematic improvement in performance had occurred.

The Ss in Experiment II were 79 undergraduate college students who were given all six tasks in small groups. The items were scored as in Experiment I. The mean total scores, standard deviations and reliability coefficients are presented in Table 3.

It would appear that the results [illegible]ask I in Experiment I were fairly well replicated in the present experiment. Performance in [illegible] six tasks was above chance. One possible interpretation of the decrease in performance across tasks would be a fatigue or boredom effect. However, some additional results from studies now in progress do not support that interpretation. In these studies each task was run by itself; the mean for Task 4 was 20.89 (S.D. = 4.26), for Task 5 the mean was 16.51 (S.D. = 4.54) and for Task 2 the mean was 22.39 (S.D. = 5.07). An alternative interpretation is that the tasks involving the linguaform stimulus mode are generally more difficult.

Product moment correlations were computed among the six tests, using the total scores. These are presented in Table 4. Inspection of this table indicates that different tasks within the same stimulus mode were more closely related than were the same replications of the behavior requirements across stimulus modes. The relatively higher correlations between Tasks 2 and 3, and Tasks 5 and 6, were most probably due to the special relationship between the tasks discussed earlier.

As in Experiment I, the data from individual Ss were divided into five performance levels based upon their total score. Learning curves were then generated for each level. Inspection of these curves revealed that no substantial amount of learning had been demonstrated in Tasks 1, 3, 4, and 6. The curves for Task 2 are presented in Figure 1. and the curves for Task 5 are presented in Figure 2. Inspection indicates that both tasks, curves for the top fifth is substantially different both in slope and distance from the bottom fifth.

In considering the overall results of Experiment II several points are worth noting. The learning curves were generated from groupings based upon total scores. The crudeness of this clustering approach is recognized but the alternatives are somewhat sparse. A sophisticated technique for clustering learning curves based upon analysis of variance has been suggested by Tucker (60). However, Fruchter and Fleishman (26) have criticized this approach for not giving adequate consideration to the "superdiagonal nature" of the correlation matrix of trials (this refers to the fact that adjacent trials are more highly correlated than these trials are correlated with more distant trials). Matrices of this type usually yield two factors; an "early-trial" factor and a "later-trial" factor. Fruchter and Fleishman proposed an alternative procedure which circumvents this particular problem (a design such that multiple measures are obtained to achieve independence of trials), but there have not been enough applications to provide a fair test of their approach.

TABLE 3

The Mean Total Scores, Standard Deviations and Reliability Coefficients for the Six Tasks

	Mean	S. D.	KR-21
Task 1	25.16	5.25	.68
Task 2	23.05	5.80	.73
Task 3	20.76	6.97	.82
Task 4	19.29	5.40	.68
Task 5	17.18	4.79	.59
Task 6	16.78	4.40	.51

TABLE 4

Product Moment Correlations for the Six Tasks

		Tasks					
		1	2	3	4	5	6
	1	-	.42	.38	.36	.30	.24
	2	.42	-	.51	.27	.37	.32
Tasks	3	.38	.51	-	.21	.33	.28
	4	.36	.27	.21	-	.42	.44
	5	.30	.37	.33	.42	-	.73
	6	.24	.32	.28	.44	.73	-

A primary issue revolves around the optimal technique for clustering individuals independently of an a priori information about the individuals. The capability for this type of grouping is seen as a necessary complement to the approach of examining differences in learning curves which have been clustered according to certain individual differences variables. As noted clustering individual curves instead of an overall averaging technique leads to what should be referred to a "group differences" as opposed to "individual differences." These group differences may or may not be systematically and meaningfully related to any other variables. These differences may be trivial and be explained as a function of random differences in the perception of the instructions (6).

Another point which merits consideration, and is perhaps more basic, is that grouping techniques involve the measurement of the dependent variable. In their work on the relationship between I.Q. and learning Zeaman and House (67) used samples of retardates and reported that the length of the "initial plateau" was the learning curve parameter which appeared to be the most sensitive to other individual differences variables. The "initial plateau" in a learning curve is the first region in which the curve establishes a clearly defined region of near zero slope, usually following a sharp increase in slope. This length is one of the greatest differences between the first and last groups in the curves in Figures 1 and 2. Further work is needed to determine the potential of this and other learning curve parameters for demonstrating systematic and useful individual differences.

The results of Experiment II do suggest some directions for future research. In the present design, it was theorized that Task 1 or 4 represented a more "basic" process than was represented in Task 2 or 5. In retrospect, just the opposite may be true. Learning to discern pattern from "noise" (Task 2 or 5) may well be the most basic; at any rate it evidently is the task in which learning is exhibited.

Experiments I and II have been concerned primarily with efforts to cluster learning curves with no a priori information. In this sense, these experiments have been concerned with group differences. The remainder of the paper will be concerned with an attempt to approach the general issue of the role of individual differences in performance of SCF from a perspective more in line with more traditional investigations of individual differences. The first of these variables -- Personality -- has been treated as a separate experiment in the interest of clarity; the data were actually taken at the same time as those of Experiment II.

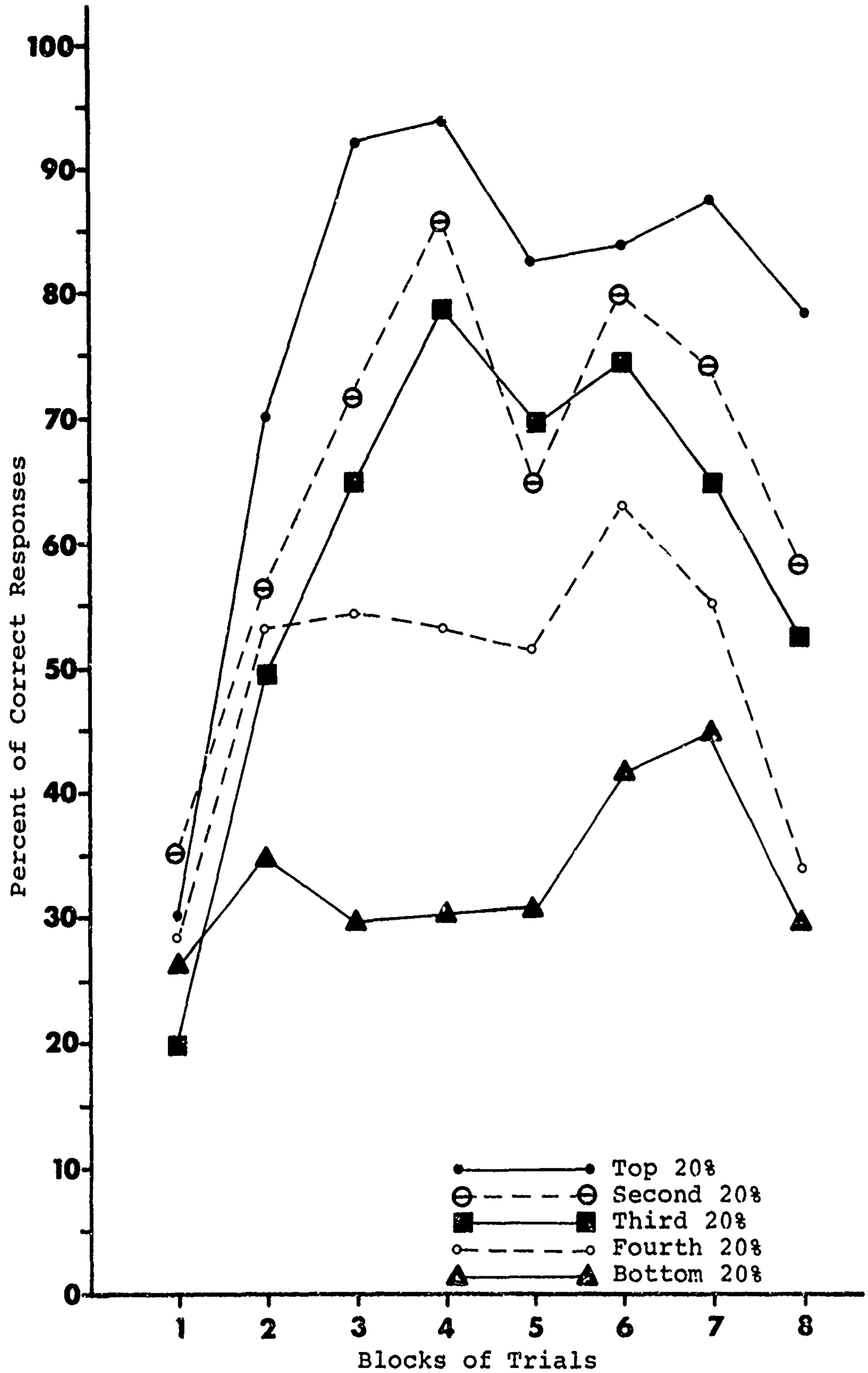

Fig. 1. LEARNING CURVES FOR TASK 2 FOR THE FIVE GROUPS DEFINED IN TERMS OF THEIR TOTAL SCORES IN THAT TASK

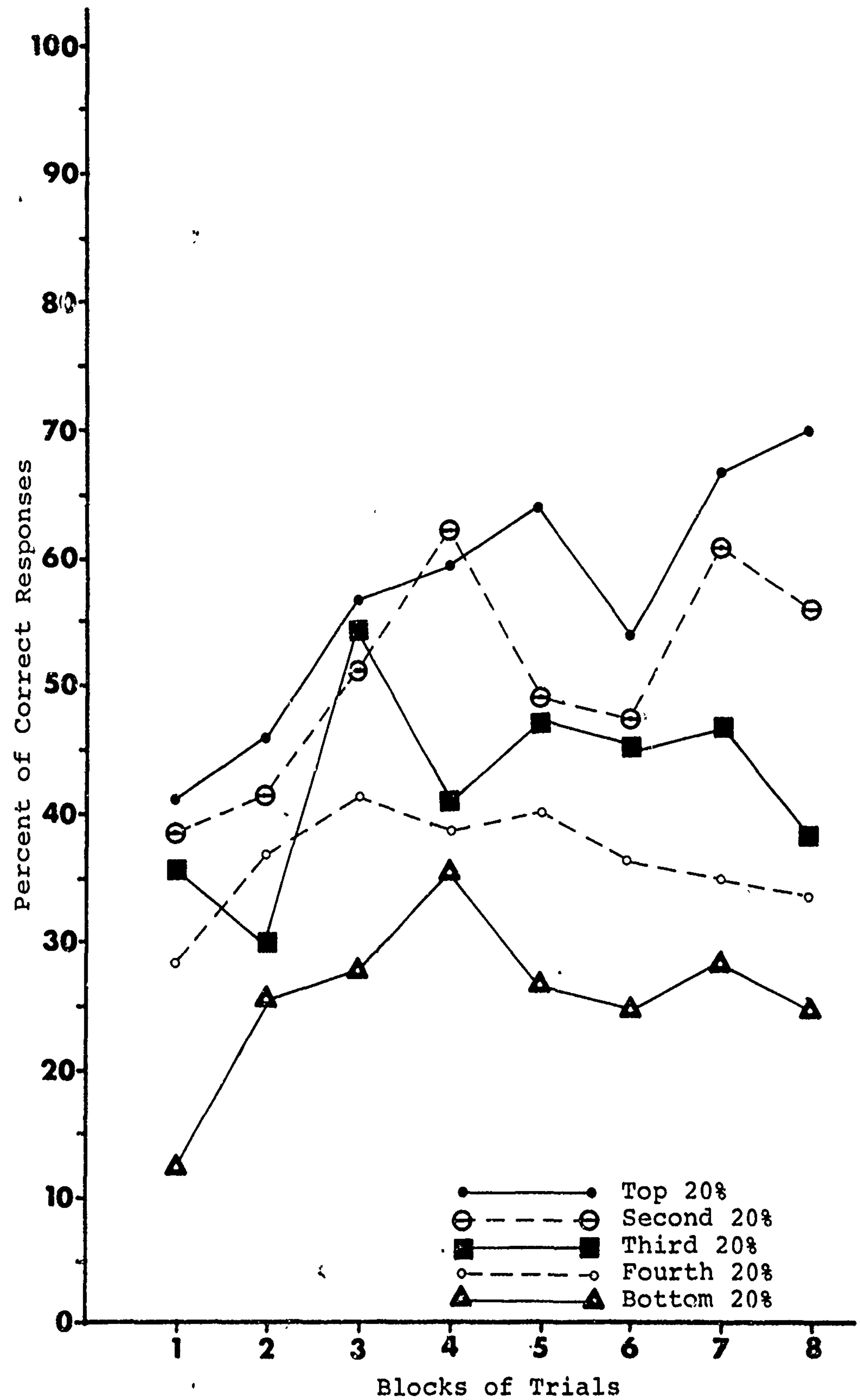

Fig. 2. LEARNING CURVES FOR TASK 5 FOR THE FIVE GROUPS DEFINED IN TERMS OF THEIR TOTAL SCORES IN THAT TASK

EXPERIMENT III -- PERSONALITY

In examining the role of personality variables as mediators of performance in the SCF task, some consideration must be given to the selection of the variables. On the basis of the many studies which have demonstrated various parameters associated with performance in the task, it is difficult to imagine that the personality variables which have been primarily associated with clinical evaluation would be useful predictors. It would seem more profitable to examine conceptual schemes which have sought to elucidate personality-type variables within the framework of cognitive functioning.

This approach may be generally characterized as seeking to describe and predict behavior based upon a system of cognitive processes. "Personality variables" reflect individual differences in the operation of these processes.

The conceptual scheme which appeared to be one one of the most promising for the establishment of a relationship between personality-type individual differences variables and performance in the SCF task was that of Witkin (65). Witkin's reasoning has evolved from his earlier concern with field-dependence and field independence to a more powerful conceptualization involving "cognitive differentiation" (65). At a very general level, Witkin's studies show that people do differ with regard to the degree of differentiation with which they perceive the environment and that these differences are manifested in certain cognitive tasks.

This notion appeared to be closely related to what would be thought to be determiner of successful performance on the SCF task. Specifically, it was hypothesized that greater cognitive differentiation should facilitate performance on the SCF task.

The Ss were 57 undergraduates at Cleveland State University. The measure of cognitive differentiation was the Embedded Figures Test (EFT) which has been substantially established in Witkin's work (65). The measures of SCF were the six tasks which had also been used in Experiments I and II. The EFT requires the S to find a simpler geometric design (seen previously) in a more complex array of color and geometric design. The dependent measure is the time it takes the S to complete each of the 12 items. It is interesting to note that the mean total time for college students in this task is 651.84 seconds with an S.D. of 441.63 (Temporary Manual Embedded Figures Test) suggesting that some individual differences did exist in the EFT task.

In the present study, the mean was 620.61, with an S.D. of 380,42; thus the results were consistent with what should be expected. Product-moment correlations were computed among each of the individual EFT items as well as the EFT total score and each of the six tasks.

Examination of these correlations revealed that no relationship existed between any of the individual EFT items, or the EFT total score, and the six SCF tasks (the highest correlation was .26, the modal correlation was .13). It should be noted that all of the individual EFT items correlated substantially with the EFT total score, indicating internal consistency reliability.

At this point it is difficult to speculate regarding the completely negative results. No clues emerged during the collection of the data to suggest any possibilities for future research within this vein (each of the eight experimenters kept a lag of each experimental session in which he recorded anything he thought pertinent). Logically, it would still seem that measures in the area of cognitive-control are more closely related, both theoretically and methodologically, to performance in the SCF task than any other type of personality individual differences variable. Pursuant to this line of reasoning, measures which might be considered would be the Stroop

Color-Word Test (56 [measures cognitive interference]), Pettigrew's Category Width Scale (45 [measures categorizing behavior]), Kelly's Rep Test (40 [measures perceived social complexity]) and experimental procedures designed to measure individual differences in visual scanning (27).

EXPERIMENT IV -- INTELLIGENCE

The assessment of the role of intelligence in SCF performance is fraught with complexities. On balance, this overlap is potentially the most exciting of all the individual difference variables from the standpoint both of theoretical development and of practical application. Basically, these complexities involve specifying a conceptualization of intelligence and relating that conceptualization to "learning" as it relates to performance in the SCF task.

Traditionally intelligence has been conceptualized within the perspective of an I.Q. score on a Wechsler or Stanford-Binet Test. This conceptualization has been referred to as "psychometric intelligence" (36, 37, 38) indicating its close historical association with the area of psychological assessment. The relationship between I.Q. and learning has been approached primarily from the standpoint of retardate functioning (8, 41, 67).

An alternative conceptualization view "intelligence" as just one of several highly related human abilities. This approach dates back to Woodrow's (66) classic article which pointed out the lack of relationship between learning variables and general "ability" measures such as intelligence. Fergusen (21, 22) suggested that by means of transfer, abilities exert their effects differentially in learning situations. Stake (55) was concerned with individual differences in certain learning tasks with reference to various aptitude and achievement tests. Duncanson (9) used a smaller subset of Stake's tasks and obtained results which suggested that certain learning factors (in particular concept formation) were independent of ability factors. Further efforts have been made to delineate the nature of the task variables on the one hand and some type of taxonomy of human abilities on the other (23, 24, 25).

A third major approach is Guilford's (29, 30) Structure of Intellect Model. Guilford's model is presented as a three dimensional matrix; one dimension represents five basic kinds of mental operations, another dimension is concerned with four information-content categories and the third stands for six basic kinds of products of information. From its initial inception Guilford has strived to "fill-in" the three-way intersecting cells with representative tasks. To some extent, Dunham, Guilford, and Hoepfner (10) managed to incorporate the relatively unsystematic abilities approach into Guilford's modes.

A fourth major position is the development approach taken by Piaget (46, 47). Basically Piaget proposes a system of evolving intellectual processes which begin with simple functions such as memory span and proceed sequentially to more complex processes involving synthesis and integration. Elkind (12) emphasizes that differences between the psychometric and Piagetian approaches:

". . .derive from the unique ways in which. . .(they). . .approach and view intelligence and not from any fundamental disagreements regarding the nature of intelligence itself. . .the differences are due to the fact that the two approaches are interested in assessing and describing different facets of intelligent behavior (p, 323)."

He goes on to state that these differences arise with respect to their respective treatments of (1) genetic causality, (2) the description of mental growth and (3) the contributions of nature and nurture.

It would seem rather obvious that a meaningful examination of SCF's potential contribution to this area would necessitate a systematic program of research spanning several years. It should be noted, however, that the study of Aiken and Williams[a] is an admirable effort to a first step at examining the interface between Piagetian theory and SCF theory and methodology. Any future program of research would have to take into account the four major positions as well as less developed positions such as Cattell's (5) fluid vs. crystallized intelligence and White's (64) hierachically-arranged learning processes. It is somewhat safe to predict that this endeavor will not be simple. Even though the process of conceptualizing SCF performance in terms of intelligence will be complex, certain characteristics of this approach suggest enormous potential. Both the individual items as well as a collection of items in SCF tasks can be objectively specified and quantitatively controlled. The tasks are essentially non-verbal in nature. The approach has extensive communication with the vast literature on human perception and information processing. Perhaps most importantly, SCF tasks are capable of demonstrating learning within one 50-minute testing situation, while at the same time measuring differential capacity.

As an initial small step in this direction a study was designed which maximized the use of well established variables. Specifically the study sought to extend the findings of a study by Shields, Gordon, and Evans (52) which reported a modest relationship between SCF performance and I.Q. The present study was designed to cast a larger "net" by considering a measure of behavioral observation (a teacher rating scale) and performance on achievement measures as well as an I.Q. measure similar to that used by Shields, et al. It was also decided to use a sample of sixth graders which would (1) extend the Shields and Gordon study into a theoretically important sample and (2) establish communication and complement the efforts of Aiken and Williams[b].

The Ss were 53 sixth graders (31 males and 22 females) in a middle-class, suburban, public elementary school. The task was composed of 60 three-choice oddity problems with either low, medium or high difficulty which had been developed and used by Aiken and Williams.[c] The stimuli were eight-sided polygons generated from two prototypes to form two classes. The Ss were administered the task singly or in pairs. The other information collected was (1) the Ss' I.Q. as measured by the Hennon-Nelson (Form A), (2) math achievement score (Iowa Achievement Test), (3) reading achievement score (Iowa Achievement Test) and (4) ratings by two teachers, who were familiar with the students, on 19 bipolar adjectives which were hypothesized to be associated with various aspects of "intelligence," both narrowly and broadly defined. This scale, along with the correlation between the teachers' judgments is presented in Table 5. It can be seen that with the exception of scales 11 (Not Very Curious-Curious) and 14 (Generally Anxious-Generally Calm) the magnitude of the correlation indicate adquate interobserver reliability.

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[a] Aiken, L. S. & Williams, T. W. Development aspects of schematic concept formation: The acquisition of class concepts in a nonverbal context. Submitted for publication Oct. 1971.

[b] Ibid

[c] Ibid

TABLE 5

Scales Used to Obtain Teacher Ratings and Correlations Between Ratings by Two Teachers

The 19 Scales and The Correlations

	Scales	Interobserver Correlations
1.	Creative-Uncreative	.52
2.	Attentive-Inattentive	.79
3.	Short Span of Attention-Long Span of Attention	.72
4.	Seems to Learn Quickly-Seems to Learn Slowly	.75
5.	Quickly Comprehends Spoken Material-Slow to Comprehend Spoken Material	.68
6.	High Need for Explicit Instruction-Not Frustrated by a Lack of Explicit Instruction	.55
7.	High Tolerance for Ambiguity-Low Tolerance for Ambiguity	.53
8.	Insensitive to Other Peoples' Feelings-Sensitive to Other Peoples' Feelings	.66
9.	Liked by Most of the Other Students-Not Liked by Most of the Other Students	.74
10.	Seems Contented with School-Seems Discontented with School	.58
11.	Not Very Curious-Curious	.30
12.	Generally Active-Generally Passive	.50
13.	High Intelligence-Low Intelligence	.76
14.	Generally Anxious-Generally Calm	.39
15.	Good in Mathematics-Poor in Mathematics	.76
16.	Poor in English-Good in English	.63
17.	Quickly Comprehends Written Material-Slow to Comprehend Written Material	.69
18.	Independent Problem Solver-Solves Problems Better with Help	.50
19.	Overall, a Good Student-Overall, Not a Good Student	.78

A mean total score, and a mean sub-score for each level of difficulty of the SCF task, was computed for males, for females, and for total group. These results are presented in Table 6. For purposes of comparison, similar data (5th graders) from Aiken and Williams[a] study if also included in Table 6. Aiken and Willimas reported no sex differences and a significant problem difficulty effect. The means in the present study would appear to indicate a similar conclusion.

The 17 reliable descriptor scales were subjected to factor analysis by the principal components method. Two factors were extracted, which accounted for 82 percent of the variance (Factor I = 72 percent, Factor II = 10 percent). This factor matrix is presented in Table 7.

It would seem fairly apparent that Factor II is almost singularly defined by the scale of "Generally Active-Generally Passive," However, the scales of "Creative-Uncreative" and "Independent Problem Solver-Solves Problems Better with Help" have relatively substantial secondary loadings on Factor II. Therefore, it was decided to compute factor scores for both factors to examine the possibility, as slight as it might seem, that the variance represented in the second factors was related to some of the other measures.

Product moment correlations were computed among the various obtained measures and are presented in Table 8. The significant correlations between the SCF total score and the scores on the various levels of difficulty were not surprising. The magnitudes of the correlations between the SCF variables and I.Q. are somewhat less than those reported by Shields, Gordon, and Evans (52 [correlation between SCF and California Test of Mental Maturity = .36, $p < .01$]). Differences in tasks, measures of I.Q. and nature of different samples all may have contributed to this difference. In another sense, however, the present study replicates their findings that SCF performance is modestly related to traditional measures of I.Q. This replication is also supported by the significant, but low, correlations between Total Score, Low Difficulty, and Math Grade Equivalent; a result also reported by Shields, Gordon, and Evans (52). The high correlations among the variables of Reading Grade Equivalent, Math Grade Equivalent and I.Q. again are fairly consistent with what would be expected. The variable of Age did not appear to make a meaningful contribution to any of the other relationships.

The patterning of the correlations of the two teacher rating factors is interesting indeed. The first factor appears to represent a traditional conceptualization of intelligence and intellectual achievement. Even though the second factor is substantially related to the first factor, this factor is significantly correlated with the SCF variables of Total Score and Low Difficulty, whereas the first factor is not. It is doubtful that a more clear-cut relationship could have been expected given the small proportion of variance (10 percent) accounted for by Factor II.

Learning curves for each level of difficulty were computed and are presented in Figure 3. A two-way Anova with repeated measures on one factor yielded a significant level of difficulty effect ($F = 226.1$, D.F. = 2, $p < .01$), a significant trials effect ($F = 20.2$, D.F. = 6, $p < .01$), and a significant trials x level of difficulty interaction ($F = 17.1$, D.F. = 12, $p, < .01$). Examination of these curves indicates that the above results reflect, to some extent, the decrease in performance across trials for the high difficulty items. One interpretation of this decrease in performance is that as the S learned the schema, his discrimination space was "tightened" to exclude the less redundant patterns.

TABLE 6

The Means and Total Scores for Males, Females and Total Group for Each Level of Problem Difficulty From the Present Study and That of Aiken and Williams (1971)

	Males		Females		Total Group	
Difficulty Levels	Aiken & Williams	Present Study	Aiken & Williams	Present Study	Aiken & Williams	Present Study
Low	18.59	17.06	19.04	18.57	18.82	18.36
Medium	12.64	12.93	12.74	12.39	12.69	12.70
High	10.27	9.90	10.44	9.26	10.36	9.66
Total All Levels	41.5	41.1	42.2	40.1	41.8	40.7

TABLE 7

The Factor Matrix for the Teacher Rating Scales

(Loadings below .45 have been excluded)

Variable	Factor 1	Factor 2
1. Creative	.71	.48
2. Attentive	.89	
3. Long Span of Attention	.93	
4. Learns Quickly	.95	
5. Quickly Comprehends Spoken Material	.95	
6. Frustrated by a Lack of Explicit Instruction	.90	
7. High Tolerance for Ambiguity	.87	
8. Sensitive to Other People's Feelings	.83	
9. Liked by Most of the Other Students	.81	
10. Seems Contented with School	.81	
11. Generally Active		.91
12. High Intelligence	.94	
13. Good in Mathematics	.90	
14. Good in English	.91	
15. Quickly Comprehends Written Material	.93	
16. Independent Problem Solver	.73	.57
17. Overall, a Good Student	.96	

TABLE 8

The Correlation Among the SCF Tasks, I.Q., Reading Achievement, Math Achievement, and the Teacher Rating Factors

		1	2	3	4	5	6	7	8	9	10
Total Score	1		.78**	.76**	.65**	.23*	.18	.25*	-.05	.14	.25*
Low Diff.	2	.78**		.37**	.37**	.30**	.21	.26*	-.19	.20	.26*
Med. Diff.	3	.76**	.37**		.20	.23*	.15	.18	-.05	.04	.11
High Diff.	4	.65**	.37**	.20		-.05	.03	.10	.14	.08	.21
I.Q. Score	5	.23*	.30**	.23*	-.05		.79**	.65**	-.46**	.78**	.42**
Reading Grade Equivalent	6	.18	.21	.15	.03	.79**		.78**	-.21	.75**	.29*
Math Grade Equivalent	7	.25*	.26*	.18	.10	.65**	.78**		.11	.73**	.44**
Age	8	-.05	-.19	-.05	.14	-.46**	-.21	-.11		-.29*	-.14
Factor 1	9	.14	.20	.04	.08	.78**	.75**	.73**	-.29*		.56**
Factor 2	10	.25*	.26*	.11	.21	.42**	.29*	.44**	-.14	.56**	

**p <.01

*p <.05

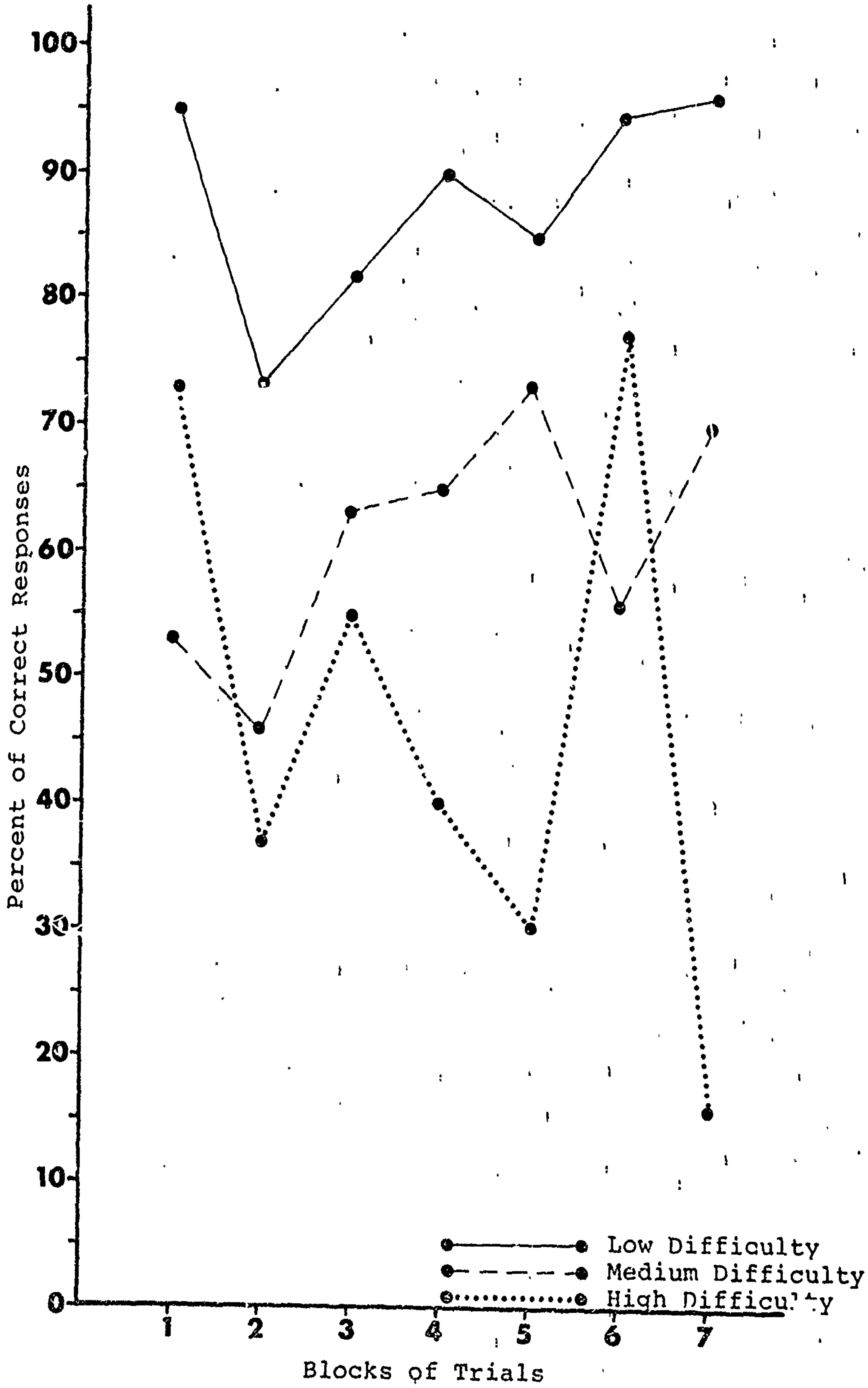

Fig. 3. LEARNING CURVES AT LOW, MEDIUM, AND HIGH LEVELS OF DIFFICULTY

The Ss were divided into a high I.Q. group (N = 18, range of scores 120-137, $\overline{X}$ = 127) and a low I.Q. group (N = 18, range of scores 75-106, $\overline{X}$ = 94.1) and learning curves for each group within each level of difficulty were computed. These curves are presented in Figure 4. An analysis of variance over levels of I.Q. and trials, within the low difficulty condition, yielded an I.Q. effect which was nonsignificant (F = 2.63, D.F. = 1), and a significant trials effect (F = 7.64, D.F. = 6, $p < .01$). A similar analysis within the medium difficulty condition yielded a significant I.Q. effect (F = 4.46, D.F. = 1, $p < .05$) and a significant trials effect (F = 6.82, D.F. = 6, $p < .01$). The trials x I.Q. interaction was not significant in either analysis.

Several conclusions are suggested by the overall results of this experiment. SCF performance does not significantly overlap with any of the traditional measures of classroom ability and aptitude. Differences in I.Q. appear to be marginally related to SCF performance. In a general but important way, these results replicate and extend the findings of Shields, Gordon, and Evans (52), who found relationships very similar to the results of the present study with a different measure of I.Q., a different task and a sample of of adolescents. More importantly, the present study suggests that SCF performance is related to a classroom performance factor other than traditional intelligence. The demonstration of this relationship using observational data is also an important methodological contribution to this approach.

Perhaps the most important task to be addressed in future studies is that of developing other scales of semantic descriptors to increase the definition of Factor II. The three scales which defined this factor in the present study (creative, active, and independent problem solver) suggest a profile of an individual who is capable of significant performance on certain task dimensions, but who deviates, perhaps in interest or motivation, from standard practices to the extent that he does not necessarily show-up well on traditional aptitude and achievement indices. A replication of the existence of Factor II, and the relationship between it and SCF performance, but not I.Q. or reading or math achievement, would be an important and exciting supporting step toward the development of the notion of SCF performance tapping potential which traditional measures are presently not capable of assessing.

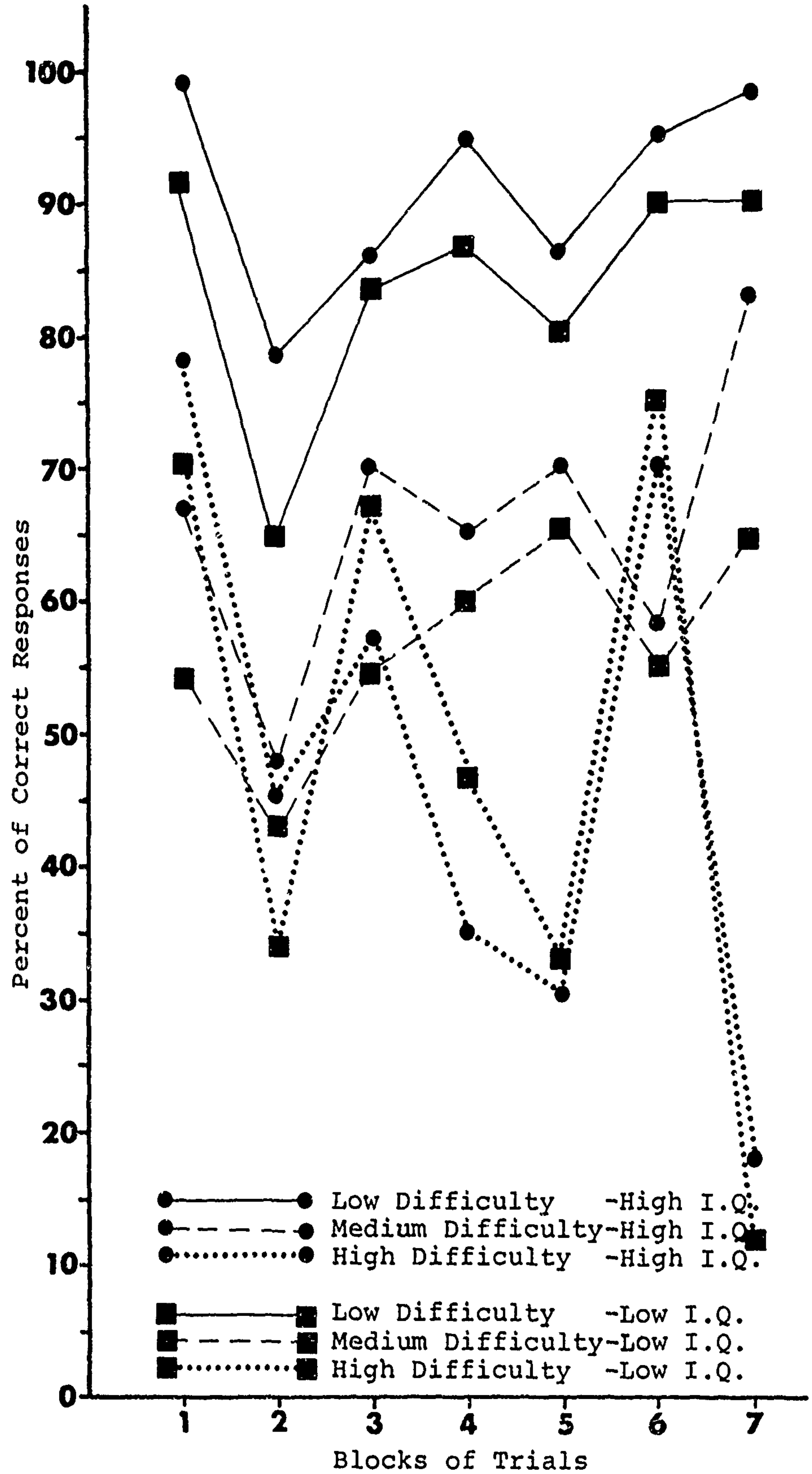

Fig. 4. LEARNING CURVES AT LOW, MEDIUM, AND HIGH LEVELS OF DIFFICULTY FOR THE HIGH AND LOW I.Q. GROUPS

EXPERIMENT V -- RACE

Issues associated with this variable are very much related to the behavior geneticists' approach to the definition of individual differences; the broad questions which regard conceptualizing intelligence; and specifically, factors such as I.Q. which were (are) thought to be related to differential learning ability. These points have received a great deal of attention as a function of their publicized prominence.

The primary dimension which serves as a common denominator for the above mentioned points is that of the nature of the contribution of genetic/constitutional variables vs. the nature of the contribution of experiential variables to the development of intellectual processes. The debate has been a lively one. Jensen (39) states the seemingly obvious point that, "It is when we attempt to force either of the two extreme interpretations on the data that we must either strain credulity or severely restrict the range of phenomena that can be explained (p. 40)."

Jensen and many others in the field have been particularly interested in the relationship between learning abilities and intelligence across various race and socioeconomic categories. He concludes, based upon reviewing a wide range of studies that, (39):

> ". . .children from a low socioeconomic background who have measured I.Q.'s in the below-average range from 60 to 80 perform in general much better on a variety of association learning tasks than do middle-class children in the same range of I.Q. . . .low SES children who are above average in I.Q. do not show learning performance that is significantly different from the performance of middle-class children of the same I.Q. This finding holds in Caucasion, Negro and Mexican-American groups (p. 65)."

His theoretical interpretation of these results proposes two types of mental processes: Level I which involves associative learning ability and Level II which involves conceptual or abstract reasoning. Level I processes are best measured by such things as digit span whereas Level II processes are best measured by nonverbal intelligence tests, highly loaded on the "g" factor. Level I ability is necessary but not sufficient for the manifestation of Level II ability according to Jensen. He goes on to state (or speculate) that Level I ability is distributed about the same in lower and middle-classes whereas Level II ability is distributed about a higher mean in middle than lower classes (he makes no allusions to any differential distributions across race categories).

Farnham-Doggory (19) has presented a series of studies and interpretations in an attempt to address some of the same issues as Jensen, but perhaps from a more operational perspective. One of her major conclusions was that Negroes (the only race sample she had available) did not really suffer any kind of I.Q. deficit; instead, their lower performance on I.Q. tests was a function of the darker pigmentation in their eyes. This theory was first proposed by Pollack (48, 49).

As in the case of intelligence, a meaningful approach to these issues as they relate to SCF performance would require a systematic program of study. However, an opportunity arose very recently to administer the task developed by Aiken and Williams[a] and used in Experiment IV to 23 Negro sixth graders (16 males and 7 females) in a lower class parochial shcool. Other data which will be made available include I.Q. math achievement and reading achievement. Unfortunately, it was not possible to collect teacher ratings as in Experiment IV. It was felt that the data would be useful as a pilot study for future research.

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[a] Aiken & Williams, op. cit.

The only partial results available at the present time are the mean total scores for the whole group and males and females, and the mean scores at each level of difficulty for males and females. These means and total scores are presented in Table 9 for purposes of comparison with similar data from Aiken and Williams[a] and Experiment IV. The results of the present experiment seem to be quite similar to the other two studies with the exception of the high difficulty items where the means in the present study are slightly higher. Any speculative interpretation would certainly be useless without proper statistical analyses, therefore further comment is not warranted.

CONCLUSION

Taken together, the results of the five experiments provide support and promise for future studies seeking to more fully determine the role of individual differences in SCF. These studies also suggest that there is a good probability that the theoretical conceptualization and methodologies of schema theory have a significant contribution to make to the area of individual differences in general, and conceptualizations of the nature and assessment of human intelligence in particular.

[a] Aiken & Williams, op. cit.

TABLE 9

Results From the Present Experiment, The Study by Aiken and Williams (1971) and Experiment IV

	Males			Females			Total Group		
Difficulty Levels	Aiken and Williams	Experiment IV	Present Study	Aiken and Williams	Experiment IV	Present Study	Aiken and Williams	Experiment IV	Present Study
Low	18.59	17.06	18.13	19.04	18.57	17.14	18.82	18.36	17.63
Medium	12.64	12.93	13.38	12.74	12.39	11.71	12.69	12.70	12.54
High	10.27	9.90	12.06	10.44	9.26	11.14	10.36	9.66	11.60
Total All Levels	41.5	41.1	43.5	42.2	40.1	40.0	41.8	40.7	41.7

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